Chapter 11

Percutaneous techniques for aneurysm repair

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INTRODUCTION

All of the devices developed to date for endograft repair of abdominal (AAA) and thoracic (TAA) aortic aneurysms are deployed through relatively large (12F to 24F) sheaths and must be positioned appropriately within the aorta after the sheaths are passed through access sites in the common femoral or iliac vessels. Traditionally, and with few exceptions, this access has required arterial exposure via cutdown skin incisions; the sheaths are passed through an open arteriotomy after vascular clamps are applied to control the vessels. In general, this process is safe, but it does require practitioners experienced in open surgical technique, and in many institutions, cutdown mandates operating room availability and general or spinal anesthesia. In addition, open arterial access does have a well-defined set of potential complications.

With smaller access sheath sizes and with the development of suture-mediated arterial closure devices, completely percutaneous treatment of both AAA and TAA is now feasible. Potential advantages to percutaneous endograft deployment include shorter procedure time, improved patient acceptance, earlier ambulation, and reduced risk for wound complications.[1-4] Percutaneous sheath placement has its own unique set of risks, and practitioners must be comfortable with the technique for the benefits to outweigh these risks. This technique requires familiarity with off-label use of suture-mediated closure devices. In addition, percutaneous approaches are facilitated by the use of endografts that can be deployed with short procedure times and through relatively small introducer sheaths.[5]

TECHNICAL CONSIDERATIONS

Preoperative selection. Thin collimation computed tomography (CT) with three-dimensional reconstruction provides all the information necessary to determine anatomic suitability for percutaneous endovascular aneurysm repair (EVAR). Appropriate device lengths and diameters can be selected on the basis of reconstructed CT data. In addition, useful information about femoral access sites and aortic accessibility through the iliac vessels can be derived from CT images. We pay specific attention to iliofemoral artery diameters, to vessel tortuosity and degree of calcification, and to the specific location of the femoral bifurcation.

Detailed techniques. General or spinal anesthesia is induced or local anesthesia is infiltrated into the skin and expected tract of the introducers. The skin is clipped before the procedure and the patients are prepared and draped to provide adequate exposure to the abdomen, retroperitoneum, and groins for potential surgical cutdown. We use an adhesive, antiseptic-impregnated drape over the prepared, exposed skin areas.

Percutaneous access is performed through small stab incisions. Arterial access is initiated with an 18-gauge needle. Care is taken to puncture the common femoral artery by first fluoroscopically imaging the femoral joint or by insonating the vessel. It is essential that anterior puncture of the common femoral artery be performed and verified. Proximal punctures into the external iliac through fibers of the inguinal ligament are less likely to be hemostatic; more distal access through the deep or superficial femoral vessels is likely to result in vascular occlusion. Puncture location is routinely confirmed by sheath injection arteriography with an ipsilateral oblique view before proceeding further.

A standard J wire is positioned in the aorta and a short 6F or 8F sheath is placed to pre-dilate the access site. After a tract is cleared through the superficial soft tissue down to the artery, using a hemostat or a finger, the sheath is then exchanged for a single, monorail, 10F Prostar XL device (Perclose, an Abbott Laboratory Company, Redwood City, Calif). Because the device delivery sheaths are all significantly larger (12F to 24F) than the 10F closure system, the two Perclose sutures are placed before the arteriotomy is enlarged by the endograft deployment sheaths—the "preclose" technique.

It helps to irrigate the three P tubes with heparinized saline before the shaft of the closure apparatus is introduced. Only after blood return is brisk through all three P tubes should the deployment ring be cocked and pulled. After confirmation of arterial flow through the marker lumen, the barrel is aligned and the ring withdrawn. The proper amount of tension is maintained on the shaft so that the artery is not compressed when the needles are deployed. This will ensure that the sutures will be placed adjacent to the arteriotomy and only in the anterior arterial wall. If there is significant resistance to deploying the needles, which usually indicates that the needles have not entered

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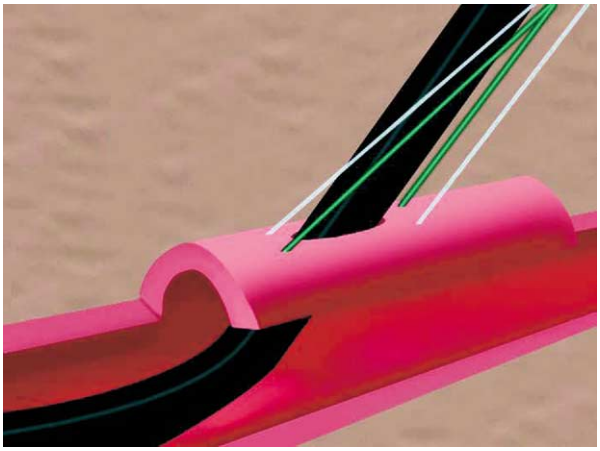

Deployed sutures.

the barrel of the device properly, a "backdown" maneuver may be performed and the device readjusted or exchanged.

The two Perclose 3-0 braided polyester sutures (one device) are deployed through the artery wall when the ring is pulled back completely. The needles are removed from the back end of the Perclose housing and each needle is cut from the suture. The closure device is partially withdrawn from the artery and the four suture ends are retrieved. The two Perclose sutures (four suture ends) are left, untied, to rest upon the patient in radial orientation until after the endograft deployment has been completed (Fig). Amplatz guidewire access is regained through the monorail side port on the shaft of the closure device. An 18-gauge entry needle facilitates this maneuver. At this point, a second closure device can be used to deploy two more sutures for longer sheaths. Patients are administered a small dose (1K units) of intravenous unfractionated heparin, and the endograft delivery sheaths then are passed into the aorta over a stiff wire and through the untied sutures.

Once the thoracic endograft has been deployed completely and with satisfaction, and after completion arteriography has been reviewed and found to be acceptable, the sheaths are removed. The sutures should be generously soaked with heparinized saline and wiped free of any thrombus; they are tied with a slipknot or a standard surgeon's knot while an assistant maintains proximal manual pressure. The sutures are trimmed as short as possible. Often, a brief period of compression is required to stop suture hole bleeding. The small stab incision is closed with a single subcutaneous suture, a subcuticular stitch, and a Steri-Strip (3M, St. Paul, Minn).

The Sutura SuperStitch (Sutura, Inc, Fountain Valley, Calif) is an 8F single-suture arterial closure system designed for treating up to 10F sheath punctures. Off-label large sheath closure has been reported with this single-stitch device. The company has double and triple suture closure systems in development, based on similar core technology, that have been designed for arterial closure with up to a 24F sheath.

DISCUSSION

Endovascular treatment of infrarenal AAAs has become commonplace. Thoracic endografts are not far behind. These industry-manufactured thoracic devices are presently being used to treat aneurysms, dissections, and traumatic transections in the United States. One device has been approved for treatment of aneurysms in the United States and at least three more are presently in trials. These same devices have been available in European markets for some time now. Early results suggest that advantages to endoluminal repair of thoracic aortic pathology will be equal to or greater than those for AAAs.

Complete percutaneous repair of thoracic aortic pathology is feasible. The advantages of complete percutaneous endograft deployment are small but real compared with device deployment through open femoral cutdowns. Percutaneous aortic repair requires special expertise and practitioners must become familiar with particular arterial closure devices before they abandon open access.

Suture-mediated closure devices such as Prostar XL can be used off-label to repair the defect that remains after removal of the larger sheaths used during endovascular aortic therapies.[1,2,6] Deployment of one or two of these devices per femoral artery provides for safe and secure arterial closure through a simple stab incision in the groin.

Different strategies for percutaneous repair may be necessary, depending on the experience of the team and on the availability of facilities necessary for immediate open cutdown, if this were to become necessary. Presently we consider most of our thoracic endovascular candidates for treatment with percutaneous techniques. We convert immediately to an open cutdown if bleeding, stenosis, or femoral artery injury is an issue. This is feasible because we have access to excellent fixed imaging in a sterile operating room. We avoid percutaneous treatment for patients with small, calcified, or aneurysmal femoral vessels, patients with previous femoral dissection or history of prior use of a closure device, and patients with inaccessible iliacs. We found that obese patients can be particularly challenging but that it is this patient population that has the most to gain from avoiding a larger incision. A conservative selective approach should certainly be used during the initial percutaneous learning curve and when preferred imaging and an operating room environment are not present in the same location.

We began our percutaneous EVAR experience by using the suture-mediated closure devices on arteries that were fully exposed surgically. This step develops visual familiarization with the devices' mechanisms, anticipated problems, and the expected resistance during each of the deployment steps. After achieving technical proficiency with the devices, reducing the levels of anticoagulation, and insisting on anterior common femoral artery puncture, complications have become extremely rare and percutaneous thoracic aortic repair has become a routine option.

There are both real and theoretical advantages to percutaneous therapy. In an earlier review of AAA pa-

tients from our institution, 47 patients with bilateral percutaneous access were compared with 35 patients with femoral cutdown. Patients who underwent percutaneous endograft deployment had more rapid repair, and we were able to treat more patients with local or regional anesthesia rather than a general anesthetic. Intraoperative conversion to cutdown occurred in <15% of these patients. Patients were able to ambulate immediately after the procedure and had short recovery times. Wound complications after hospital discharge, including infection, femoral neuropathy, and complications arising from lymphatic disruption, were not uncommon after open cutdown. In our initial experience, such late complications were nonexistent after percutaneous treatment.[7] We have now completed nearly 200 complete percutaneous infrarenal aneurysm repairs and 20 thoracic repairs. Although we have had two late pseudoaneurysms arise after patient discharge, our overall incidence of complication has dropped <8%.

Despite these reasonable results, caution is warranted because significant complications may occur. Device entrapment, acute arterial thrombosis with limb ischemia, arterial injury, suture breaks resulting in hemorrhage, arterial dissection, suture infection, and pseudoaneurysm or arteriovenous fistula formation have all been described after use of this closure technique.[3-5,8-14] We have found that it is particularly important that the common femoral be the artery of choice for access. If the external iliac artery is punctured through the inguinal ligament, the suture-mediated closure device will not deploy properly, and early or late complications are likely to occur. Access distal to the common femoral artery can also be problematic. When punctures involve the superficial or deep femoral vessels, suture-mediated closure can result in vessel occlusion and acute limb ischemia.

As with open cutdown, clinicians need to closely monitor for arterial occlusion and hemorrhage. Bleeding complications and acute arterial occlusion should be recognized early. These complications can be substantial, and they often require treatment with surgical exposure of the accessed artery immediately, before the patient is taken from the operating suite. In our published review of AAA patients, 7% experienced immediate access site complications that required urgent surgical attention.[7] We have experienced just one access complication in the 20 patients treated percutaneously with thoracic devices. This patient developed a significant retroperitoneal bleed on the side of the 6F puncture contralateral to the large sheath insertion site.

To date, we have experienced no significant adverse events directly related to the large sheath percutaneous insertion site. These complications are easily addressed when they are identified in the operating suite. As a corollary, we continue to recommend that complete percutaneous aortic repair be performed by surgeons and in an operating room. Alternatively, percutaneous therapy can be undertaken in a cardiac catheterization lab or an interventional radiology suite, when both a surgeon and an operating room are on standby for immediate assistance and transfer if problems arise.

Presently, we consider all AAA and nearly all thoracic endograft patients to be candidates for percutaneous repair. Although patients with very small, severely calcified, or aneurysmal iliac or femoral arteries must be approached with caution, and clearly any patient who requires a prosthetic chimney conduit to gain aortic access needs open arterial exposure, many patients can safely be treated percutaneously with great success.

CONCLUSION

Newer endograft technology has made complete percutaneous treatment of AAA and thoracic aortic pathology feasible in most patients. Elements of success include an appropriate strategy for arterial access, familiarity with the technical nuances of the closure system, and the use of endoprostheses with predictably short procedure times and smaller access sheaths. Percutaneous treatment of aortic diseases should initially be reserved for carefully selected patients and should be performed in a sterile environment or where open arterial access can be obtained rapidly, if required.

Percutaneous access does have some advantages over open femoral artery cutdown, but percutaneous approaches to endovascular aortic repair are not free of risk. Once a significant amount of experience has been gained and the practitioner becomes comfortable with the specific techniques, most patients can be considered for percutaneous repair. Furthermore, greater benefits are expected as improved percutaneous techniques and newer suture-mediated closure devices, including those specifically designed for large vessel closure, are developed.

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